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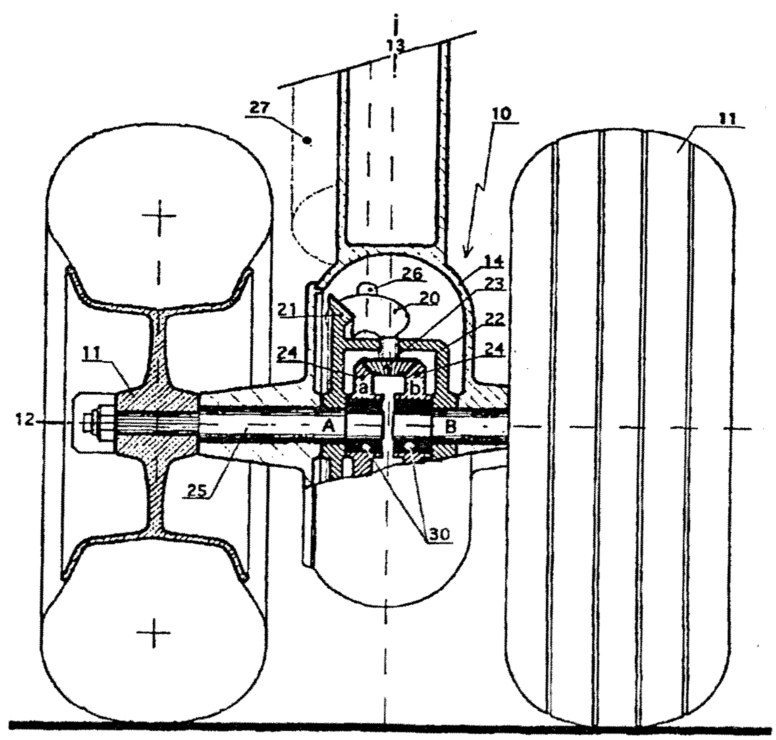
(54) Title: AIRCRAFT LANDING-GEAR DRIVE SYSTEM

(57) Abstract

The present invention relates to a system for driving the landing gear of an aircraft. An aircraft having wheel driving means associated with at least one of the wheels of the landing gear is described. Preferably, the nose gear is driven, having two wheels (11), both wheels being drivable through a differential gear assembly. Alternatively, the wheel driving means are associated with at least one wheel (41) of each main landing gear assembly. Preferably, a motor (27, 44) powered by the auxiliary power unit of the aircraft is used to drive the wheels of the landing gear. An assembly is also described for driving the wheels (11) of a twin-wheeled nose gear (10) of an aircraft, the assembly comprising an electric or hydraulic motor (27) in operative connection with a differential gear assembly, each wheel being mounted on an axle in forward operative connection with a respective half-shaft (25) of the differential gear through a free wheel mechanism (30).



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AIRCRAFT LANDING-GEAR DRIVE SYSTEM

The present invention relates to a system for driving the landing gear of an aircraft.

The power for all ground movement of an aircraft during taxiing is provided by the thrust generated by the main engines of the aircraft, be they turbine, turbo-fan or turbo-prop engines. The degree of thrust is controlled by the pilot adjusting the power of the engine.

A considerable volume of fuel is burnt by commercial aircraft alone in taxiing before and after flight. For example, a DC9 will burn around 150 US gallons (570 litres) of fuel and a Boeing 747 typically around 260 US gallons (980 litres). A typical main European airport may have an average of six hundred movements per day. Assuming taxiing fuel consumption is just 130 US gallons (500 litres), this equates to around 80,000 US gallons (300,000 litres) of Jet A1 aviation fuel per day. Over a full year this amounts to around 29 million US gallons (110 million litres).

When one considers that the European community alone has thirty five main airports, in excess of one billion US gallons (3.75 billion litres) of fuel are burnt each year solely for taxi movements around airports. In burning these large amounts of fuel, not only is a great deal of money and natural resources wasted, but the aircraft produce correspondingly great amounts of exhaust gases which contribute to the high degree of air pollution associated with airports.

Accordingly, there is a need to provide an alternative method of manoeuvring aircraft on the ground at airports.

In its broadest aspect the present invention provides an aircraft with one or more driven ground wheels. Preferably, the power to drive the wheels is provided by the auxiliary power unit of the aircraft.

In one preferred embodiment, the front carriage wheel(s) (of the nose gear) are driven. Preferably, the wheels of a nose landing gear assembly having two wheels are driven through a differential gear assembly.

In another embodiment, at least one wheel of at least one main landing gear assembly on each side of the aircraft is driven.

Typically, power is delivered from the auxiliary power unit by the wheels via an electric or hydraulic motor associated with each driven wheel.

The above and other aspects of the present invention will now be illustrated in greater detail, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows in cross section the front carriage wheels of an aircraft in accordance with a first embodiment of the present invention;

Figure 2 shows in axial cross section the embodiment of Figure 1;

Figure 3 illustrates schematically the main gear of an aircraft fitted with apparatus for powering the wheels in accordance with a second embodiment of the present invention; and

Figure 4 illustrates in axial cross-section one carriage of the main gear of the embodiment of Figure 3.

Referring to the Figures 1 and 2, a front carriage (shown generally at 10) of an aircraft is provided with two wheels 11 rotatable about an axis 12. The whole carriage 10 is rotatable about a further axis 13 perpendicular to axis 12, to steer the aircraft.

In a cavity 14 of the front carriage 10 there is mounted a differential gear comprising a bevel pinion 20 driving a crown wheel 21 mounted on a housing 22 carrying differential pinions 23 driving bevel gear 24 mounted on half shafts 25. Each carriage wheel 11 is mounted at the end of one of the half shafts. The bevel pinion 20 of the differential gear is driven by a propeller shaft 26 of a motor 27.

Motor 27 may be supplied with fluid from a hydraulic pump powered by the auxiliary power unit of the aircraft. Alternatively, motor 27 may be electrically powered, taking its supply from the auxiliary power unit (APU) in a conventional manner. Commercial aircraft are provided with an (APU) which is used to provide power for the aircraft services, for example lighting and control circuits, whilst the aircraft is on the ground without requiring powering up of the main engines. As an APU is typically run at a flat rate, that is, the power output is not variable, ample surplus power is available from the APU to provide the necessary energy to drive motor 27 (typically 200-300

HP is available) - it is to be noted that the apparatus of the present invention does not result in any increase in fuel consumption by the aircraft. The generation of hydraulic and electrical supplies from aircraft APUs is well known in the art. In most aircraft, suitable hydraulic pumps and electrical generators are already present. Some aircraft may, however, require such apparatus to be upgraded.

Conventionally, the front carriage wheels are not braked and so there is no braking gear in the front carriage 10 with which the installation of different gear apparatus might otherwise interfere. Nor will the additional apparatus interfere with the raising or lowering of the landing gear.

As shown, in a preferred embodiment, each bevel gear 24 is coupled to its respective half shaft through a free wheel mechanism 30 of otherwise conventional construction. The free wheel mechanism if of particular use when the aircraft is coming in to land. The free wheel arrangement will allow the wheel 11 to spin faster than the differential gear would otherwise allow, this being of benefit if the pilot has forgotten to disengage the carriage wheel drive mechanism prior to take off. Due to the presence of the free wheel arrangement, the apparatus allows only forward movement of the aircraft. However, rearward movement is possible by rotating the carriage 10 by 180° or by mechanically locking the free wheels and reversing the direction of rotation of the motor 27. Thus forward movability of the aircraft is obtained independent of the need of towing bars and/or tractors.

In aircraft having a single-wheel nose gear arrangement, the differential gear box can be omitted. Typically in such an arrangement, motor 27 drives a crown wheel 21 connected directly (or preferably through a free wheel arrangement) to the axle of the wheel. This arrangement is generally similar to that described below with reference to driven wheels on the main landing gear.

The conventional hydraulic steering of the front carriage is unaffected by installation of the driving gear described, nor will there be an affect or change in the hydraulic braking system on the main gear of the plane. Preferably, a braking action performed by the pilot will deactivate the front carriage wheel driving mechanism automatically, in the event that the pilot has inadvertently forgotten to disengage the mechanism.

The pilot in the cockpit will be able to engage and disengage the front carriage wheel driving apparatus by means of a switch in the electrical power supply or by a switch actuating an electro-hydraulic valve, as appropriate by the nature of the motor 27 used. The power supplied to motor 27 will be variable under the control of the pilot to increase or decrease the speed of the taxiing aircraft. Conventional electrical and hydraulic control mechanisms are suitable for this purpose.

Figures 3 and 4 illustrate the application of the present invention to the wheels 41 of the main landing gear of an aircraft. At least one wheel on each side of the aircraft is driven. Both wheels on each leg 42 may be driven and if the aircraft has more than one leg on each side, one or both wheels on each leg may be driven.

Figure 4 illustrates a typical arrangement wherein just one of the wheels 41 of one leg 42 of the main gear is driven. Motor 44 drives a bevel pinion 45 in a cavity of the carriage 40. Pinion 45 in turn drives a crown wheel 46 or endless screw. Crown wheel 46 may be mounted directly upon a wheel axle 47 or more preferably, indirectly through a free wheel mechanism 48 as shown. As a free wheel mechanism will prevent rearward motion, the wheels of the main gear may be reversed by providing a free wheel locking arrangement as described above, such that the direction of the motor may be reversed.

If an aircraft is not provided with an auxiliary power unit, power to drive the motor 27 can be obtained from running a single main engine at its minimum speed. Nevertheless a huge saving in the amount fuel required and the resultant air pollution would still be obtained. For accurate hanger manoeuvres, where the auxiliary power unit may not be in operation, an independent power source may be used, for example an external trolley fitted with batteries for an electrically powered mechanism or with an additional hydraulic pump for an electro-hydraulic motor.

Even during landing the wheel driving mechanisms of the present invention do not obstruct the free run of the wheels. The presence of a differential gear box in the nose gear makes possible the movement of the carriage at any desired steering radius even on a steady spot rotation. In this case, the nose gear carriage would rotate with one of the two wheels acting as a pivot.

CLAIMS

1. An aircraft having wheel driving means associated with at least one of the wheels of the landing gear.

2. An aircraft as claimed in claim 1 wherein the nose gear (10) has two wheels (11), both wheels being drivable through a differential gear assembly.

3. An aircraft as claimed in claim 1 wherein the wheel driving means are associated with at least one wheel (41) of each main landing gear assembly.

4. An aircraft as claimed in any one of claims 1 to 3 wherein the wheel driving means comprises a motor (27,44) associated with each driven wheel (11,41), the motor being electrically or hydraulically actuated.

5. An aircraft according to any one of claims 1 to 4 wherein the power to drive each driven wheel is derived from an auxiliary power unit of the aircraft.

6. An assembly for driving the wheels (11) of a twin-wheeled nose gear (10) of an aircraft, comprising an electric or hydraulic motor (27) in operative connection with a differential gear assembly, each wheel (11) being mounted on an axle in forward operative connection with a respective half-shaft (25) of the differential gear through a free wheel mechanism (30).

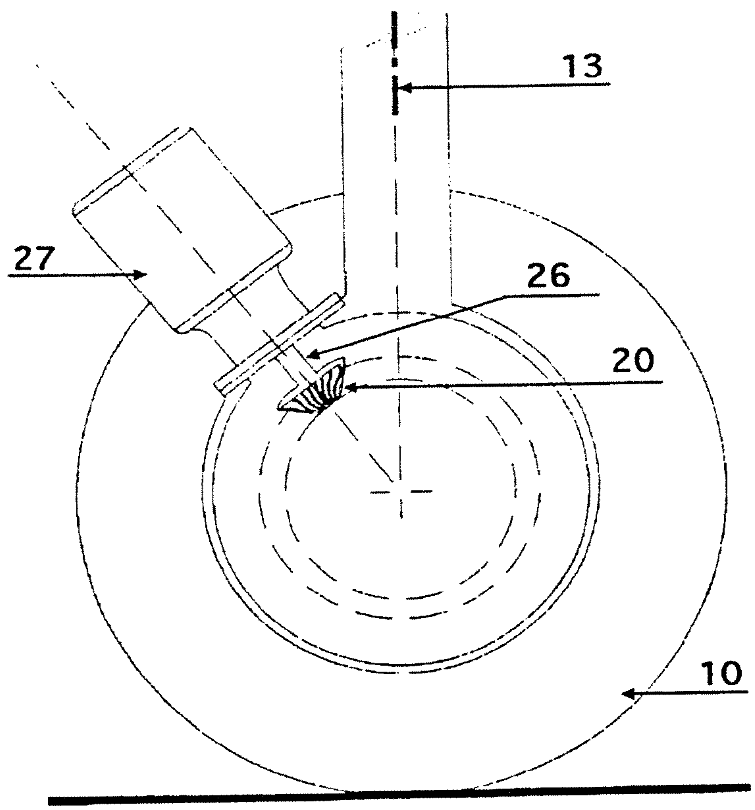

FIG 1

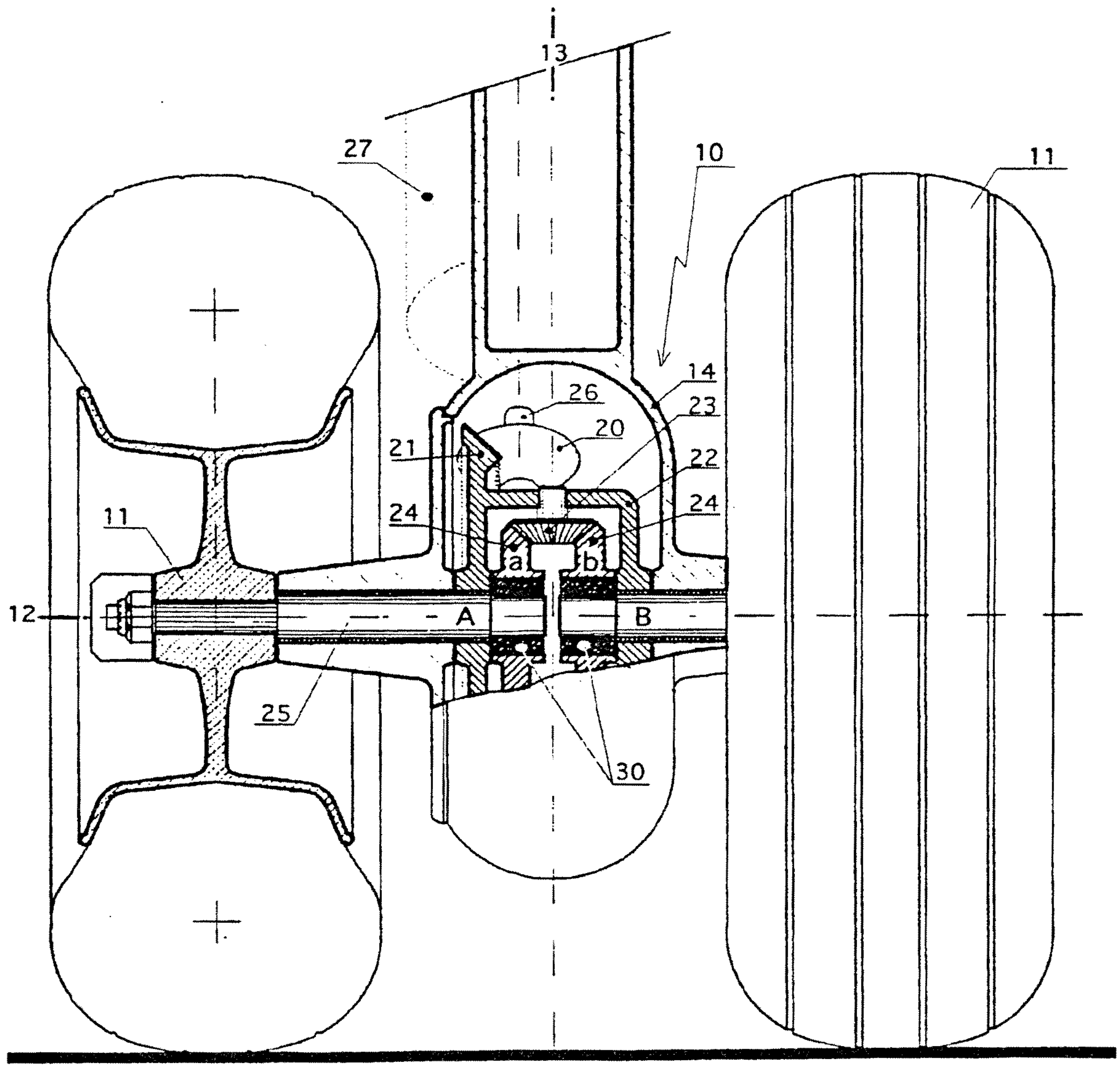

FIG. 2

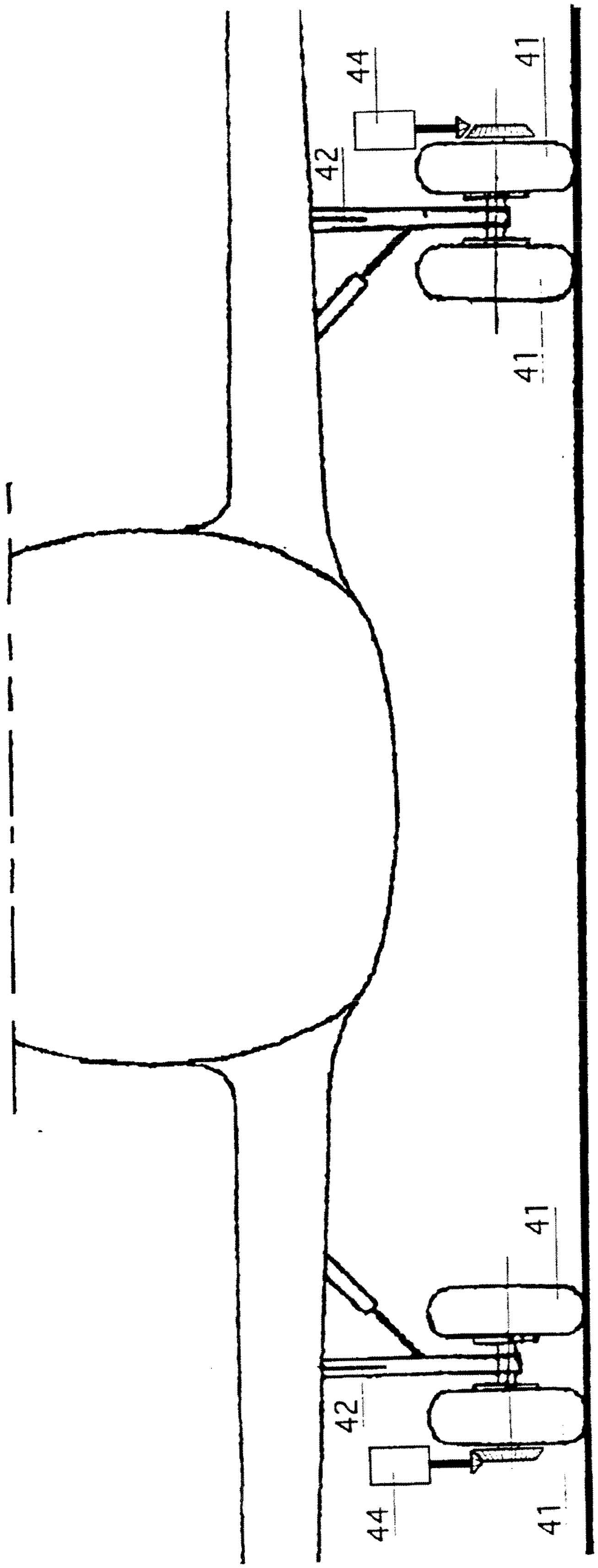

FIG. 3

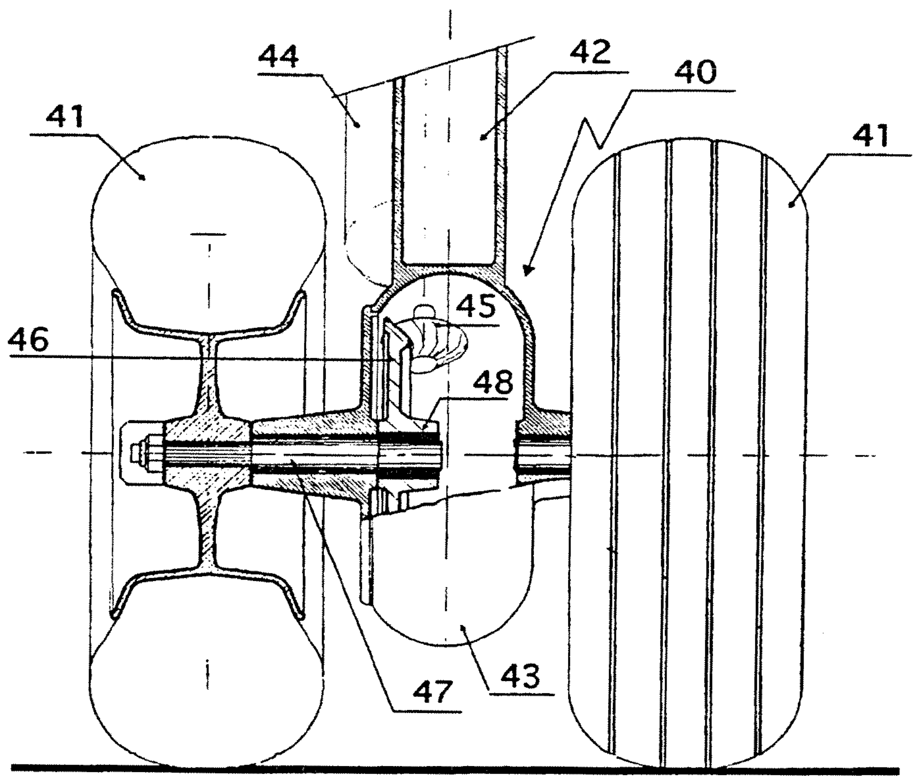

FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 95/01527

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B64C25/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B64C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,3 059 712 (HAUTAU) 23 October 1962 see column 1, line 31 - line 68	1,4
A	see column 3, line 6 - line 21 ---	6
X	US,A,3 762 670 (CHILLSON) 2 October 1973 see column 2, line 41 - line 55 see column 3, line 8 - line 27 see column 11, line 66 - column 12, line 14 ---	1-5
X	FR,A,1 368 754 (RECHERCHES ETUDES PRODUCTION) 29 June 1964 see page 1, column 1, line 5 - line 20 see page 2, column 1, line 44 - page 2, column 2, line 6 see page 2, column 2, line 44 - page 3, column 1, line 22 --- -/--	1,2

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
5 July 1995	12.07.95

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A	US,A,3 034 748 (KOUP) 15 May 1962 see column 2, line 23 - line 29 -----	5

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Information on patent family members

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3059712	23-10-62	NONE	
US-A-3762670	02-10-73	NONE	
FR-A-1368754	04-12-64	NONE	
US-A-3034748	15-05-62	NONE	